Exploring Student Perceptions of a Station-based Teaching Approach in The Human Anatomy and Physiology Laboratory

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Exploring Student Perceptions of a Station-based Teaching Approach in The Human Anatomy and Physiology Laboratory

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Abstract
We adapted a station-based teaching approach (SBA) to teaching in the Human Anatomy and Physiology I Laboratory (Anatomy and Physiology). In the SBA students rotate through stations that are taught by the instructor or teaching assistant (TA). At each station students are presented with content using a teaching modality selected to maximize student engagement and encourage material application and integration. We surveyed students taught using the SBA approach and the independent study approach to assess student perceptions of the effectiveness of SBA method. Relative to the independent study, SBA improves student perceptions of their engagement, comfort level, and ability to apply material. The impact of TAs on student perceptions of SBA was also made evident in survey results. Overall, a SBA is beneficial for learning in the Anatomy and Physiology laboratory for students with diverse science backgrounds and majors. It is an effective teaching strategy that can be easily adapted to large and small classrooms, and for various topics. doi: 10.21692/haps.2018.007

Key words: anatomy pedagogy, station-based learning, small group learning, teaching assistants

Introduction
Human Anatomy and Physiology is a common pre-requisite for all healthcare-related professions. In many institutions, including ours, Anatomy and Physiology is a high enrollment course containing students from diverse science backgrounds. The Anatomy and Physiology course traditionally has a reputation for being extremely difficult, and many students start the semester very apprehensive. Students that enter our classrooms and laboratories often feel unprepared for the amount of information that they are expected to learn, understand, and apply. Many become overwhelmed by the sheer magnitude of new vocabulary and concepts that they are expected to retain. Student uneasiness may contribute to their overall course satisfaction, which is affected by factors like perceived learning effectiveness, learning community support, and perceived course learnability (Eagleton 2015). To help students become more engaged with the material, facilitate learning, reduce the stress typically associated with this course, and increase course satisfaction, we implemented a station-based teaching approach in the Anatomy and Physiology lab. As part of this implementation, we recruited and trained teaching assistants to help teach the stations.

Human Anatomy and Physiology at Elizabethtown College is a two-semester course. Anatomy and Physiology I is typically taught in the fall and focuses on the integumentary, nervous, and musculoskeletal systems. Anatomy and Physiology II is taught in spring, focusing on the cardiovascular, respiratory, renal, endocrine, and reproductive systems. Both courses have a lecture portion, split into two sections of approximately 45 students, and a laboratory portion that is divided into five sections of up to 18 students. Both lecture and lab meet twice a week, for 80 minutes. In the lecture, we use a physiology text (*Human Physiology: An integrated approach, sixth edition* by Silverthorn), and in lab we utilize an Anatomy Atlas (*Atlas of Anatomy, second edition* by Gilroy *et al.*) supplemented by an in-house instructions manual.

In Anatomy and Physiology I lab students study the skeletal system using real bones and plastic bone models. Muscles are studied by examining models, observing muscles on cadavers, and performing exercises and motions to understand functional anatomy. The Anatomy Atlas is used as a visual reference to support the hands-on materials. Each lab of 18 students has up to two teaching assistants (TAs) to assist the instructor. Thus, in every lab there are up to three individuals who are available to assist the students.

Anatomy and Physiology Students at Elizabethtown College
At Elizabethtown College, students in the Anatomy and Physiology course have highly diverse science backgrounds and varied majors (Table I). The only pre-requisite for this course is successful completion of General Biology I or Biology for non-majors. Anatomy and Physiology is a required course for occupational therapy and allied health majors. Occupational therapy students typically take Human Anatomy and Physiology in their sophomore year, after successfully completing General Biology I. Biology allied health majors, who include pre-physical therapy, pre-nursing, and pre-physician assistant students can take Anatomy and Physiology any time between their sophomore and senior years, although they most commonly take it in their sophomore or junior years.

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Major	Biology - Allied Health • pre-Physical Therapy • pre-physician assistant • Nursing	Occupational Therapy	Other • Music therapy • Psychology • Chemistry* • Biochemistry* • Social work
Science Background	• General Biology 1 & 2 • General Chemistry • Organic Chemistry • Genetics • Physics	• General Biology 1	• Biology for non-majors • *science background same as Biology majors

Table I. *Majors of students that take Anatomy and Physiology have diverse science backgrounds*

Station-Based Teaching

Until 2014, all students in the Anatomy and Physiology lab were responsible for learning all the required structures independently. They were provided with a list of structures they needed to know for the exam, along with descriptions of the structures to help with localizing the described bone markings. In the lab, students worked with bone specimens and were shown muscles on the cadaver. Outside of the lab, students were expected to memorize assigned muscles, along with the muscle origin, insertion, innervation, and action (also provided in a table of the in-house lab manual). While the instructor and the TA were always present during these lab sessions, they did not lecture. Their sole purpose was to help keep students on task and be available to address questions. Thus, in 2014 the main form of pedagogy utilized in the Human Anatomy and Physiology I lab at Elizabethtown College was independent study.

Example 1 – lab section with 3 TAs				
Station	Radius & Ulna	Humerus	Upper Extremity Cadaver Muscles	Upper Extremity Motions
Teacher	Instructor	TA #1	TA #2	TA #3
Example 2 – lab section with only 1 TA				
Station	Shoulder Joint	Motions	Brachial Plexus	Independent Study
Teacher	Instructor	TA	Instructor (as a class)	---

Table 2. *Examples of content presented as stations in the SBA method*

In 2015 and 2016 we began teaching Anatomy and Physiology I lab using the Station-Based Approach (SBA). In this approach, TAs and the lab instructor divide the course material into thematic stations and actively teach the material to smaller groups of students. Examples of the division of material by station are provided in Table 2. Throughout the lab, students rotate throughout stations, where they are taught by the instructor or a teaching assistant (TA). The instructor of each station utilizes a different teaching modality (bones, cadavers, physical exercises) to engage students in learning a particular section of the musculoskeletal system. We find that SBA is flexible, easy to implement using limited resources (varying TA support), and can be used to teach diverse topics of varying difficulty (Table 2).

Teaching assistants facilitate learning

Teaching assistants can be a valuable asset to course design and material delivery. Research has shown that students may benefit from integrated teaching methods involving use of TAs (Thomas *et al.* 2011).

In addition, teaching assistants can also serve as intermediaries between students and the instructor (Fig. I). Where students might not feel comfortable sharing information or posing questions to the instructor, they might find that asking TAs, who are closer to the students in age and taking similar classes, is easier and less intimidating. Similarly, through regular meetings with TAs, the professor has an opportunity to learn about common misconceptions that students have about the material, and challenges that might influence student progress in this course.

Furthermore, low achieving students might not be aware of effective learning techniques (Dunn-Lewis *et al.* 2016). By offering TAs as resources, we provide students with another opportunity to discuss effective learning strategies with their teaching assistants. At the beginning of the semester, when TAs introduce themselves to the students, they talk about how they studied for the course; reinforcing the importance of discipline, persistence, and planning. Since it is typical that a professor will advise not to cram the night before the exam, that suggestion carries little weight. However, when the same suggestion is stated by a fellow student who successfully

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completed the course the year before, students in the course take it much more seriously. Furthermore, active involvement of TAs in the lab creates an atmosphere where successful completion of the course is possible, respected, and an accomplishment to emulate (Lockspeiser et al 2008). During the semester students have multiple opportunities to observe TAs while they teach their stations and answer questions, to reinforce confidence in the TA expertise and develop a relationship with the TA. This relationship helps create an atmosphere of support and encouragement that can help students improve academically (Eagleton 2015).

Motivation for the study

During the past 3 years, we have made extensive changes to the manner in which we teach the material in the Anatomy and Physiology I laboratory. We moved from complete independent study setup that was used for decades at the college to a stations-based approach to increase student engagement, comprehension, and overall course satisfaction. Our main goal in making these changes was to create an engaging course that prepares students for their major in the health profession, to present material in a way that promotes comprehension, critical thinking, and application, and develop a learning environment that is supportive and challenging for students of all science backgrounds. In this study, we assess student perceptions of the SBA method and increased TA engagement in the Anatomy and Physiology I laboratory.

Materials and Methods

Institution information

Elizabethtown College is a small private liberal arts college in a suburban community in central Pennsylvania. Its enrollment is 1,774 of which 38% are male and 62% are female.

TA selection and training

The training of TAs, which included explicit explanations of job expectations and regular TA meetings, was implemented when we started using the SBA method in 2015 and 2016.

Teaching assistants are students who have successfully completed the two-semester Human Anatomy and Physiology sequence and have been selected through an application process. All prospective TAs sign a contract in which job expectations, appropriate code of conduct, and basic teaching suggestions are clearly stated. One of the most important expectations of all TAs is regular attendance at weekly TA meetings where TAs practice material they are assigned to teach for that week, discuss any issues or concerns they encountered during the week, and address any possible changes to the course content or schedule. Missing more than three meetings can be grounds for job termination. In addition, all TAs undergo mandatory lab safety training before the semester begins and throughout the semester, as the need arises. Once hired, TAs are provided with a manual to help them effectively fulfill the position demands. The manual includes a description of TA responsibilities, a code of conduct, a description of the procedure for properly handling specimens, teaching assignments, and a set-up guide for each lab station for the entire semester. At the end of the semester, students evaluate the TAs, and the TAs are given these evaluations as means of constructive feedback about their effectiveness as a TA.

Teaching assistants were not intentionally trained when the independent study method was used. They were not expected to teach; their only job was to help the instructor set up materials and answer student questions.

Survey and data collection

Students who took Anatomy and Physiology during 2014, 2015, and 2016 were invited via email to participate in a survey about their Anatomy and Physiology I lab experience (Tables 3 and 4). The survey was conducted online, via Survey Monkey during the spring of 2017. There was a difference between the two classes in the amount of time that had elapsed since they had taken the course that was targeted in this study; 2 years for students who had taken the course in 2014 and less than 6 months for those who took the course in the fall of 2016. All participation was completely voluntary and anonymous. The institutional review board of Elizabethtown College approved this project (IRB # 104925-1), and informed consent was obtained from all participants.

Year Course Taken	Major → Teaching Approach	Occupational Therapy	Allied Health	Other	Class Total
2014	Independent study	51	6	10	67
2015	Stations (SBA)	43	14	13	70
2016	Stations (SBA)	57	24	7	88

Table 3. *Breakdown of student participants by major and year*

The survey consisted of 22 qualitative questions and was divided into three main parts. The first portion of the survey collected factual information about when the students took Anatomy and Physiology lab, and what teaching method was utilized. The second part asked students to rate their experience in the lab, including questions about their perception of course quality. Students were asked to rate how challenging, stressful, interesting, and engaging they found the course. Finally, in the third portion of the survey, students were asked to rate the TAs on their professionalism, helpfulness, and knowledge. Options provided for responses

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Year	Teaching Approach	# respondents	% respondents
2014	Independent study	43	64
2015	Station-Based Approach	48	69
2016	Station-Based Approach	75	93

Table 4. *Study participants by year and teaching method*

were based on a 5-point Likert-based Scale. The survey did not ask for or collect any identifying information such as a student's name or email address.

Data analysis

Survey responses were compared among the three years using a one-way ANOVA. Where differences were significant ($p < 0.05$), LSD post-hoc was used. Data from two respondents were excluded from analysis due to a mismatch between the year they took the Anatomy and Physiology lab and the manner in which the lab was taught (i.e. took the lab during the years it was taught using the SBA teaching approach, but reported using independent study method).

Results

Overall, 166 students participated in the survey (Tables 4).

Evaluation of teaching method

Students from all three years, regardless of teaching method either agreed, or strongly agreed that anatomy and physiology is important for their future career (Figure 2a, ANOVA; $F_{2, 138}=1.501$, $p=0.226$) and that they learned a lot from the course (Figure 2b; ANOVA; $F_{2, 139}= 1.412$, $p=0.247$). Teaching style, independent study or stations based approach, did not have an effect on perception of course difficulty (Figure 2c, ANOVA; $F_{2, 135}=0.626$, $p =0.536$).

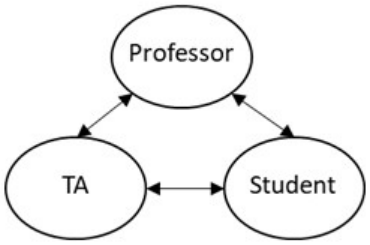

Figure 1. *Relationship between students, teaching assistants, and professors in the Anatomy and Physiology laboratory.*

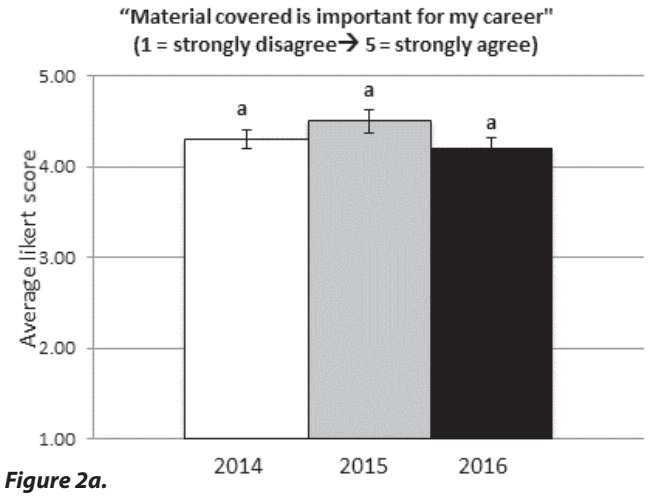

Figure 2a.

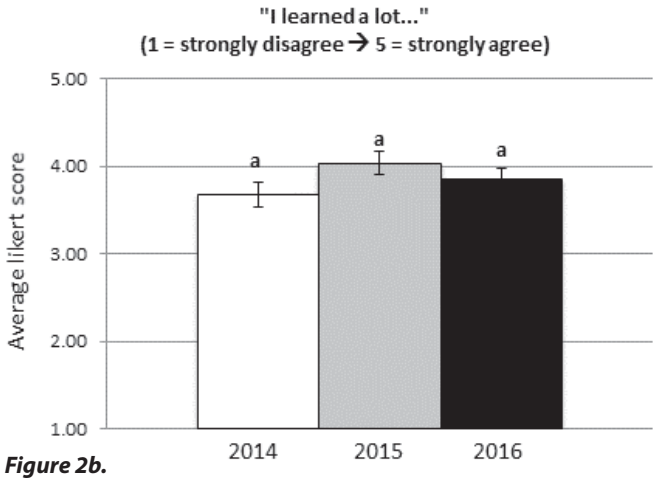

Figure 2b.

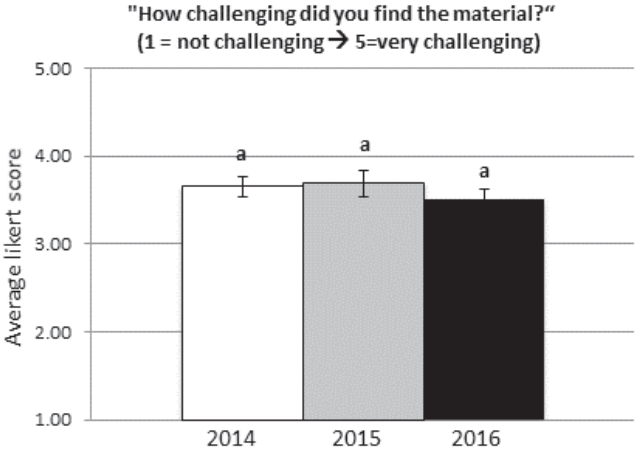

Figure 2c.

Figure 2. *Student perception of course content in station-based and independent study laboratories. Students rated their perception of course A) importance for future career, B) amount of information learned, and C) challenge level using a Likert Scale. Different letters above the standard error bars represent statistically significant differences between the teaching methods ($p< 0.05$). The bars represent the average Likert scores of students who took the course in different years, using different teaching methods; 2014 (white bar – independent study), 2015 (grey bar – SBA), and 2016 (black bar – SBA).*

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However, students taught using the SBA method reported significantly more interest and engagement with the material compared to students in the independent study cohort (Figure 3c; LSD; 2014 vs. 2015 p=0.015; 2014 vs. 2016 p=0.029). No significant differences were found between the two years where SBA was used (Figure 3c, LSD; p=0.509). Ability to apply and integrate learned material differed between the cohorts as well (ANOVA; F2, 138=4.467, p=0.013). Students taught with the SBA method (years 2015 and 2016) felt more confident that they can apply learned material, compared to the students taught using the independent study method (year 2014) (Figure 3c, LSD; 2014 vs. 2015 p= 0.004; 2014 vs. 2016 p=0.038; 2015 vs. 2016 p= 0.217). Furthermore, students taught using the SBA method reported feeling much more comfortable asking questions (Figure 3d, ANOVA, F2, 136=6.074, p=0.003; LSD 2014 vs. 2015 p=0.042; 2014 vs. 2016 p=0.001; 2015 vs. 2016 p=0.365). Students taught using the stations method also felt that stations decreased their stress levels (Figure 3a). Since students in the independent study cohort (year 2014) were never taught with the SBA method, they were omitted from the analysis of this question and the respective figure (Figure 3a).

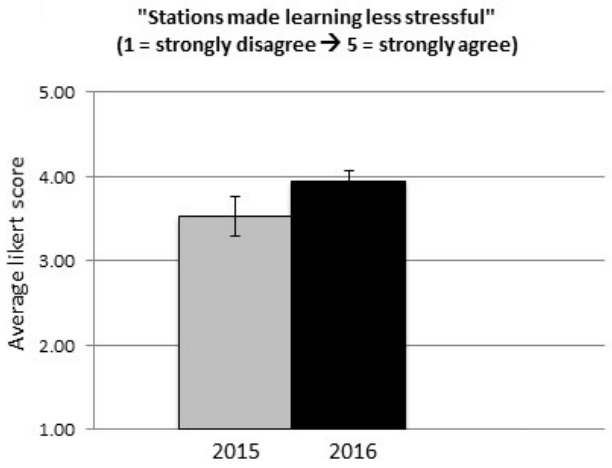


Figure 3a.

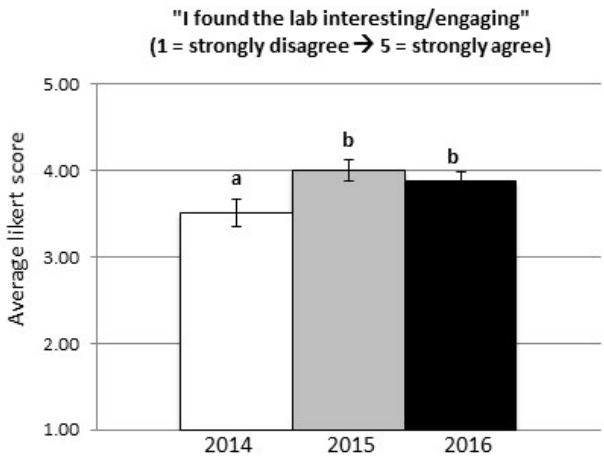
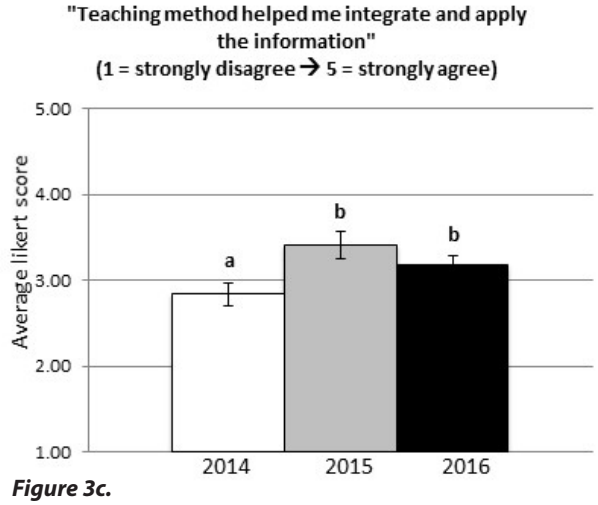


Figure 3b.



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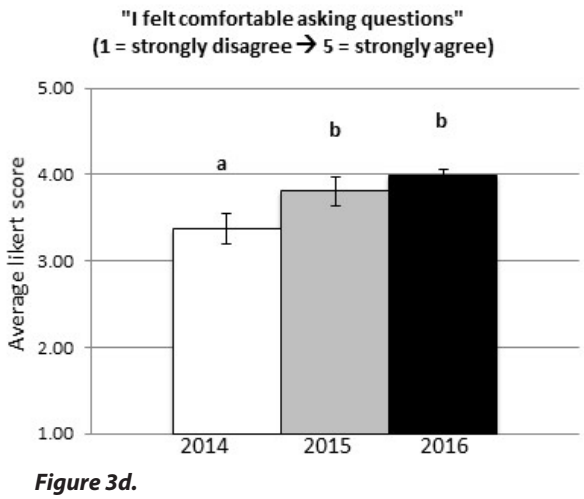

Figure 3d.

Figure 3. *Effect of teaching methods on student engagement.* ***A)*** *Stations affected student perception of stress,* ***B)*** *made the lab more engaging,* ***C)*** *helped students integrate and apply course material, and* ***D)*** *made the lab experience more interactive. Different letters above the standard error bars represent statistically significant differences between the teaching methods (p< 0.05). The bars represent the average Likert scores of students who took the course in different years, using different teaching methods; 2014 (white bar – independent study), 2015 (grey bar – SBA), and 2016 (black bar – SBA).*

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Evaluation of TA role in the laboratory

Student perception of TAs' positive impact on the classroom differed between the teaching methods (Figure 4). Differences were found in TAs overall helpfulness (ANOVA; $F_{2,138}$, $p<0.01$), their ability to facilitate learning (ANOVA; $F_{2,138}$, $p<0.01$, and decrease stress (ANOVA; $F_{2,135}$, $p=0.00$). Students taught with the SBA perceived the TAs to be more helpful (Figure 4a, LSD; 2014 vs. 2015 $p=0.000$, 2014 vs. 2016 $p < 0.01$, 2015 vs. 2016 $p=0.858$). They also felt that the TAs helped reduce the stress levels (Figure 4b, LSD; 2014 vs. 2015 $p=0.005$, 2014 vs. 2016 $p=0.000$, 2015 vs. 2016 $p=0.812$), and facilitated learning significantly more compared to the students taught using the independent study method (Figure 4c, LSD; 2014 vs. 2015 $p<0.01$, 2014 vs. 2016 $p<0.01$, 2015 vs. 2016 $p=0.976$).

Discussion

Based on the results of our survey, as well as anecdotal evidence from informal conversations with students and teaching assistants, the SBA method makes the material more engaging, interactive, and also less intimidating for students with diverse science background (Figure 3). While all students, those in the independent study cohort and in the SBA method, felt that they learned a lot in the course and all found the material challenging (Figure 2), students in the SBA method felt much more positive about their overall lab experience (Figure 3a-d). Students in the SBA method felt that the stations made their learning experience less stressful (Figure 3a).

Even though students in the SBA did not learn the material independently as the 2014 cohort did, they had opportunities to study on their own. During the first lab of the semester, students study on their own and learn to use the lab resources following a very brief introduction by the instructor. The stations approach does not officially start until the second lab. Throughout the semester, students also had other opportunities to work independently. So even though these brief exposures to independent study do not directly compare to the experience of the independent study cohort, the SBA students still have a measure of comparison allowing them to compare the two learning methods.

Whelan *et al.* (2016) suggested that students believe that the independent learning style does not facilitate learning as efficiently as the facilitated active learning approach. Another study that assessed student perceptions on small group learning indicated that students have more favorable attitudes toward material as a result of small group learning (Springer *et al.* 1999). The station-based approach improves students' perception of their ability to apply and integrate the material.

Ten-Cate and Durning (2007) found that the educational environment or learning climate appears to be important for optimizing learning. Additionally, Lockspeiser *et al.* (2008) found that peer-assisted learning helped with connecting

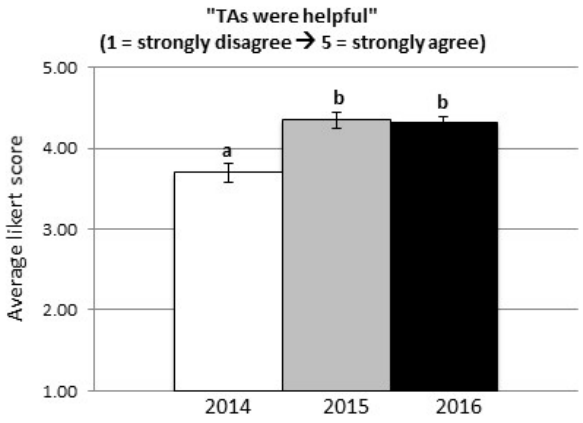

Figure 4a.

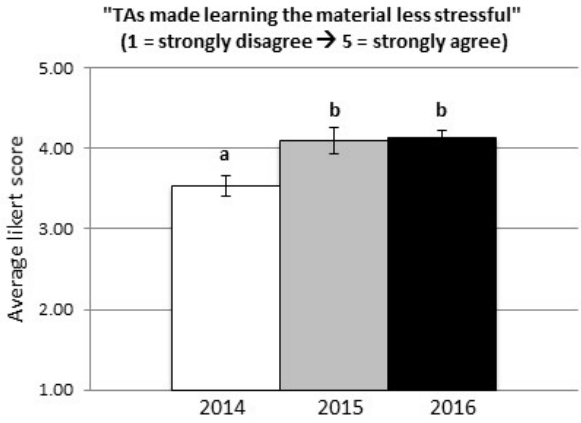

Figure 4b.

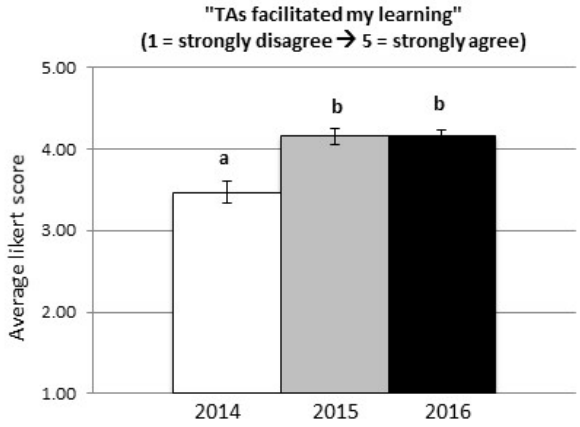

Figure 4c.

Figure 4. *Effects of TAs on student perceptions of the course. Different letters above the standard error bars represent statistically significant differences between the teaching methods ($p< 0.05$). The bars represent the average Likert scores of students who took the course in different years, using different teaching methods; 2014 (white bar – independent study), 2015 (grey bar – SBA), and 2016 (black bar – SBA).*

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various concepts taught in the course and facilitated student organization of the information. A Station-based approach allows students to feel more comfortable asking questions. Whelan *et al.* (2016) indicated that students that experienced an independent learning environment expressed that their greatest concern was lack of timely and competent response to questions. Also, students that were taught with facilitated active learning were significantly more likely to report that their questions and confusion were addressed in a timely manner. Furthermore, small groups enabled students to ask questions and solve problems to further understand the concepts and that there was more effective communication between students and teachers (Lama *et al.* 2015).

One of the limitations of our study is that we were unable to quantitatively assess whether the different teaching methods affect retention and application of the course material. However, we know from other studies that positive perceptions of teaching methods have been shown to enhance student perceived ability to learn (Thomas *et al.* 2011). There is also evidence that occupational therapy students show a significant improvement in their ability to remember and explain anatomical material when using station-based methods and having student TAs (Thomas *et al.* 2011). Notwithstanding, for future studies, it would be important to assess the effectiveness of this method, not only on building student comfort and confidence, but also on student ability to understand and retain the Anatomy and Physiology concepts.

Similarly, teaching assistants helped reduce student stress and increase overall comfort in the course (Figure 4). These findings are in accordance with Whelan *et al*. who showed that students taught with an independent learning method perceived to meet less of the course objectives and to be less successful in learning than the students who were taught with facilitated active learning with tutors. Further, while the effects of facilitated active learning were highly variable depending on teaching style of tutor, the students taught with this approach were still significantly more likely to report that laboratory tutors facilitated their learning (Whelan *et al.* 2016).

While the SBA method is an effective pedagogical method to engage students, it does have some drawbacks. One such drawback is that the number of TAs limits the number of interactive stations in a given laboratory. However, even in a class of 18 students, it is possible to develop interactive stations with one TA and the professor (Table 2). It is not essential that an instructor oversee every minute of the students' time. It is possible to have two interactive stations and then stations where students review material independently or perform carefully structured activities that reinforce material covered at other stations. Furthermore, even in the absence of TAs, stations can be developed allowing groups of students to move from one activity to the next using POGIL (Process Oriented Guided Inquiry Learning) or other forms of collaborative group work. In the case where TAs are not available, the instructor can choose to hold one station or float between stations as students work through the material.

One of the great advantages of the SBA teaching method is the advanced anatomy training one can provide to motivated students seeking to learn Anatomy and Physiology beyond the two-semester course sequence. At Elizabethtown College, Human Anatomy and Physiology is the only course students have an opportunity to take to learn about human anatomy and physiology. We do not offer an advanced anatomy or physiology course. By giving motivated students an opportunity to work as TAs in the course, we are effectively giving the students a chance to improve their working understanding of Anatomy and Physiology by teaching it to others. Through regular TA meetings where TAs review relevant content and discuss effective pedagogical techniques, TAs often learn anatomy in greater depth. During our TA meetings we have had multiple discussions with TAs as they share their experience in upper level classes such as kinesiology, internships at physical therapy clinics, and various occupational therapy fieldwork assignments. These discussions are often engaging and result in regular improvements to content delivery, incorporating useful mnemonics, activities such as physical exercises, and examples into the course content.

The presence of actively engaged TAs in the classroom also significantly improves class dynamics. TAs facilitate communication between students and the instructor and help decrease student stress (Figure 4). According to Ten-Cate and Durning (2007), a teacher with a semantic network that more closely resembles that of the learner, like a near-peer, understands learning needs more easily and can offer help more efficiently. Since near pears are potentially seen as less threatening by learners and often have a rich understanding of the stresses of the school curriculum (Ten-Cate and Durning 2007), TAs can easily identify with students in the class and offer support through tutoring, open-labs, and advice (Ten-Cate and Durning 2007, Lockspeiser *et al*. 2008). Thus, station-based teaching allows TAs to have a positive role in the course by ultimately increasing overall student comfort and engagement in the course.

Conclusions

The SBA approach is flexible, and easy to adapt to topics of varying difficulty and different audiences. This method is also easy to implement using limited resources. The SBA allows the instructor to quickly identify and correct misconceptions because material is presented in discrete chunks, which is also less overwhelming for the students.

Using stations in the human anatomy and physiology lab can be an effective method to engage students and reduce stress. By incorporating teaching assistants in the laboratory, and allowing them to actively participate in the course design

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through teaching, the students taking the course as well as the teaching assistants benefit. The students in the course benefit by gaining increased access to the educator and a better support system to help them navigate the complex world of anatomy and physiology. The teaching assistants benefit through increased exposure to anatomy, teaching experience, and ultimately, a better preparation for board exams and graduate schools.

Finally, using stations, allows the sometimes monotonous review of structures to become interesting and interactive. Stations allow the instructor to arrange course content in a way that would be most applicable to their unique student audience and to develop activities that would engage them. Because stations are inherently modular, it is possible to easily modify and adjust lab activities to adjust for student/instructor interests, needs, and changes in learning outcomes.

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About the Authors

Anya Goldina is an assistant professor of biology at Elizabethtown College. She teaches introductory biology courses, Human Anatomy and Physiology courses. Dr. Goldina received her PhD in Behavioral Endocrinology from Florida International University. Her broad research interests include animal behavior, endocrinology, and neuroscience.

Danielle Barattini is a master's degree candidate in the Occupational Therapy program at Elizabethtown College. Danielle has been a teaching assistant for the Human Anatomy and Physiology course since 2015. In addition to teaching labs, Danielle has helped develop and implement the SBA method. Danielle is conducting research related to Anatomy and Physiology and the Occupational Therapy profession for her master's thesis.

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